AIRS/AMSU/HSB Version 5 Level 1B QA Quick Start

Edited by:
Edward T. Olsen

Contributions by:

Steve Broberg, Evan Manning, Margie Weiler

Jet Propulsion Laboratory, California Institute of Technology

27 November 2017
Version 1.3.1

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA

Submit Questions to:
http://airs.jpl.nasa.gov/ask_airs

Table of Contents

Document Change Log

Date	Version Number	Reason for Change
May 2007	Initial Release	
February 2013	Version 1.1	To add updated information on AMSU channels 4 and 5 and additional AIRS epochs. To incorporate experience in evaluating AIRS channels.
March 2013	Version 1.2	Up-Date to clarify L1B V5 vs V6
July 2015	Version 1.3	Up-Date to add additional channel properties and calibration properties files

1 Introduction

There are many Quality Assurance parameters that a user may use to filter AIRS/AMSU/HSB data to create a subset for analysis. A complete description of the AIRS L1B (infrared radiances) QA interface specification is provided in Appendix A1-8 in the document:

V6_Released_ProcFileDesc.pdf

Descriptions of the L1B QA interface specifications for visible/near-ir, and the AMSU and HSB microwave radiances are provided in other sections of Appendix A1. The L1B products remain at V5 because the algorithms that create them are unchanged as of the V6 release. The QA for these products have been carried over from V5 to V6 and appear in V6 documentation.

The novice user will find the plethora of QA parameters overwhelming, hence this document provides a quick start identification of the most basic QA parameters that a user should access before using any data for analysis. The QA parameters may be static or dynamic. If dynamic, their timescale and scope can range from global to all channels to per footprint to a single channel in a footprint.

2 Quick Start QA for AIRS Level-1B Data

AIRS's 2378 channels provide rich information on surface and atmospheric temperature and composition, but because each channel corresponds to an individual physical detector, not all channels will be of equal quality, and the quality of each channel can change over time. An application using AIRS Level-1B data will be using a set of channels over a range of time. Application success will require:

1. Selecting channels which meet static quality requirements
2. Monitoring channel health over time

Initial (static) channel selection must include consideration of channel Gaussian and non-Gaussian noise and possibly spectral and spatial quality in addition to sensitivity to the constituent of interest. Dynamic checking is mostly designed to filter for cases where noise increases, but must also check for various rare data drop-outs.

2.1 Semi-static channel selection

2.1.1 Files for Semi-Static Quality Checks

The properties of the 2378 AIRS instrument detectors are individually listed in two sets of self-documenting text files. Each set has a file for each calibration "epoch". The original set are the channel properties files, which are used by the Level-1B and Level-2 algorithms. The newer calibration properties files have much of the same information plus more, and should be used when selecting channels.

Some properties of the channels change slowly with time or discontinuously whenever the instrument is warmed by a spacecraft safety shutdown or in a defrost cycle. Whenever this occurs, a new calibration epoch is started. In addition, epochs are started about twice per year in order to give finer-grained temporal information on the health of each detector. For each epoch recalibration tests are performed and new channel properties and calibration properties files are created. The current file set used in V6 Level-2 and available for offline channel selection. A smaller set of epochs and older version of channel properties files were used in processing V5 Level-1B and Level-2. The Level-1B (and Level-2) algorithms use the proper channel properties file (chosen by date of properties file and date of data) for initial processing and reprocessing from the files available to them.

The names of these files all contain a date, which is the first date for which they are valid (and supersede a calibration properties file and channel properties file containing an earlier date). As of this release, there are 26 files of each type covering the time period from 8/30/2002 to 3/23/2015. The smaller 8-file sets used by the V5 Level-1B processing are also provided for reference. Text versions are provided as ancillary files to this document:

Table 1: Calibration and Channel properties files used for semi-static channel selection (and in V6 Level-2 processing)

Calibration Properties Files	Channel Properties Files
L1B.cal_prop.2002.08.30.v9.5.0.anc	**L2.chan_prop.2002.08.30.v9.5.3.anc**
L1B.cal_prop.2002.09.17.v9.5.0.anc	**L2.chan_prop.2002.09.17.v9.5.3.anc**
L1B.cal_prop.2002.10.22.v9.5.0.anc	**L2.chan_prop.2002.10.22.v9.5.3.anc**
L1B.cal_prop.2003.01.10.v9.5.0.anc	**L2.chan_prop.2003.01.10.v9.5.3.anc**
L1B.cal_prop.2003.11.19.v9.5.0.anc	**L2.chan_prop.2003.11.19.v9.5.3.anc**
L1B.cal_prop.2004.07.01.v9.5.0.anc	**L2.chan_prop.2004.07.01.v9.5.3.anc**
L1B.cal_prop.2005.03.01.v9.5.0.anc	**L2.chan_prop.2005.03.01.v9.5.3.anc**
L1B.cal_prop.2005.07.01.v9.5.0.anc	**L2.chan_prop.2005.07.01.v9.5.3.anc**

Calibration Properties Files	Channel Properties Files
L1B.cal_prop.2006.01.01.v9.5.0.anc	L2.chan_prop.2006.01.01.v9.5.3.anc
L1B.cal_prop.2006.07.01.v9.5.0.anc	L2.chan_prop.2006.07.01.v9.5.3.anc
L1B.cal_prop.2007.01.01.v9.5.0.anc	L2.chan_prop.2007.01.01.v9.5.3.anc
L1B.cal_prop.2007.07.01.v9.5.0.anc	L2.chan_prop.2007.07.01.v9.5.3.anc
L1B.cal_prop.2008.01.01.v9.5.0.anc	L2.chan_prop.2008.01.01.v9.5.3.anc
L1B.cal_prop.2008.07.01.v9.5.0.anc	L2.chan_prop.2008.07.01.v9.5.3.anc
L1B.cal_prop.2009.01.01.v9.5.0.anc	L2.chan_prop.2009.01.01.v9.5.3.anc
L1B.cal_prop.2009.07.01.v9.5.0.anc	L2.chan_prop.2009.07.01.v9.5.3.anc
L1B.cal_prop.2010.01.01.v9.5.0.anc	L2.chan_prop.2010.01.01.v9.5.3.anc
L1B.cal_prop.2010.07.01.v9.5.0.anc	L2.chan_prop.2010.07.01.v9.5.3.anc
L1B.cal_prop.2011.01.01.v9.5.0.anc	L2.chan_prop.2011.01.01.v9.5.3.anc
L1B.cal_prop.2011.07.01.v9.5.0.anc	L2.chan_prop.2011.07.01.v9.5.3.anc
L1B.cal_prop.2012.01.21.v9.5.0.anc	L2.chan_prop.2012.01.21.v9.5.3.anc
L1B.cal_prop.2012.07.01.v9.5.0.anc	L2.chan_prop.2012.07.01.v9.5.3.anc
L1B.cal_prop.2013.06.10.v9.5.0.anc	L2.chan_prop.2013.06.10.v9.5.3.anc
L1B.cal_prop.2015.03.23.v9.5.0.anc	L2.chan_prop.2015.03.23.v9.5.3.anc

Table 2: Calibration and Channel properties files used in V5 Level-1B (and V5 Level-2) processing

Calibration Properties Files	Channel Properties Files
L1B.cal_prop.2002.08.30.v9.5.0.anc	L2.chan_prop.2002.08.30.v9.5.1.anc
L1B.cal_prop.2002.09.17.v9.5.0.anc	L2.chan_prop.2002.09.17.v9.5.1.anc
L1B.cal_prop.2002.10.22.v9.5.0.anc	L2.chan_prop.2002.10.22.v9.5.1.anc
L1B.cal_prop.2003.01.10.v9.5.0.anc	L2.chan_prop.2003.01.10.v9.5.1.anc
L1B.cal_prop.2003.11.19.v9.5.0.anc	L2.chan_prop.2003.11.19.v9.5.1.anc
L1B.cal_prop.2005.03.01.v9.5.0.anc	L2.chan_prop.2005.03.01.v9.5.1.anc
L1B.cal_prop.2012.01.21.v9.5.0.anc	L2.chan_prop.2012.01.21.v9.5.3.anc
L1B.cal_prop.2012.07.01.v9.5.0.anc	L2.chan_prop.2012.07.01.v9.5.3.anc
L1B.cal_prop.2013.06.10.v9.5.0.anc	L2.chan_prop.2013.06.10.v9.5.3.anc
L1B.cal_prop.2015.03.23.v9.5.0.anc	L2.chan_prop.2015.03.23.v9.5.3.anc

We recommend that users choosing Level-1B (or Level-2 Cloud-Cleared) channels for their research refer to the calibration properties files rather than the channel properties files. The information contained in calibration properties files

has been expanded with the user in mind and will be of greater utility. The channel properties files are provided for continuity and to support the Level 2 software. We are planning to phase out the channel properties files in later releases. Both sets of files include a documenting header describing their contents.

The calibration properties files provide the quality indicators on a per-channel basis. Key indicators are the frequency centroids and widths, NEdT at 250 K and 300 K, spatial centroids, **AB-weight**, **Spec_qual**, **n3sigma** and **npops.** Users may work out an effective NEdT for any scene temperature from the values quoted at 250 K and 300 K.

For analyses spanning multiple epochs, channels should be selected which have good behavior in all applicable epochs.

2.1.2 Evaluate Channel Static Radiometric Quality (Noise)

- Check the **NEdT250** field in appropriate (by date) calibration properties file and avoid using channels for which **NedT250** > 1 K
- Check the **npops** field in the appropriate (by date) calibration properties file and avoid using channels for which **npops** > 1. This can indicate non-Gaussian noise.
- Pick a noise limit and filter out channels exceeding it using **Max_NEdT250**. This will eliminate channels that sometimes exceeded this noise level during the test. Dynamic noise testing is still needed to eliminate other cases.

Users may also further filter channels by thresholding on **n3sigma**.

2.1.3 Evaluate Channel Static Spectral Quality

Channels with higher values of **Spec_Qual** are less well characterized in terms of SRF shape. They may still be useful as inputs to regression-like algorithms. If a well-characterized spectral response is required:

- Check the **Spec_qual** field in appropriate (by date) calibration properties file and avoid using channels for which **Spec_qual** > 2. A more rigorous test is to require that **Spec_qual** = 1.

2.1.4 (Advanced) Evaluate Channel Static Spatial Quality

If sensitivity to channel co-registration is a concern:

- Check the X- and Y- centroid fields in the appropriate (by date) calibration properties and avoid using channels with absolute values greater than 0.25 degree

Or all channels can be used but individual scenes eliminated using dynamic spatial quality checking.

2.2 Dynamic checking

Entire spectra can be unusable because of missing data or instrument tests. Individual channels may also become unusable at various timescales. When individual channels are eliminated, applications may continue using other channels if they are robust enough, or else they can create gaps in their products.

2.2.1 Dynamic Per-Field-of-View Quality Checks

These checks affect the usability of all channels in a Field-of-view (spectrum).

2.2.1.1 Dynamic Per-Field-of-View Instrument State Check

Before using any AIRS L1B radiance, check the value of the corresponding "**state**" to ensure that it is equal to zero. There is one "**state**" value per field-of-view (FOV), and it is valid for all 2378 channels in that FOV. The "**state**" valids and their meaning are:

State Valid	State Value	Meaning
Process	0	normal data
Special	1	instrument in special calibration mode when these data were taken (e.g., staring at nadir)
Erroneous	2	data known bad (e.g., instrument in safe mode)
Missing	3	data are missing

2.2.1.2 (Advanced) Dynamic Per-Field-of-View Scene Inhomogeneity Check

If sensitivity to channel coregistration is a concern then use the **Sceneinhomogeneous** flag, the **Rdiff_swindow** and **Rdiff_lwindow** flags and/or the radiances themselves to restrict data selection to uniform scenes where co-registration is not an issue. All flags are full swath fields, i.e. there is a value for each of the 90x135 AIRS footprints in the L1B radiance granule.

2.2.1.3 (Advanced) Glint Checks

Each scan contains a "**glintlat**" and "**glintlon**" giving the location of the solar glint center at the time in the middle of that scan. Users can use these or the

per-field-of-view "**sun_glint_distance**" to check for possibility of solar glint contamination.

Infrared glints can occur over clouds as well as water and can extend up to several hundred km.

2.2.2 Dynamic Per-Channel Quality Checks

These checks affect individual channels over various timescales.

2.2.2.1 Dynamic Noise Checking per Six-Minute Granule

Channels sometimes become noisier. Check **NeN** for each channel in each granule and discard channels that are too noisy or continue to use them but with lower weight because of the lower SNR. There is no indicator per granule of changes in non-Gaussian noise, but a sudden increase in **NeN** can be an indicator that non-Guassian component also increased. **NeN** is noise for a 250 K scene in radiance units. It can be converted to NEdT at 250 K using the Planck function.

2.2.2.2 Dynamic Per-Scan-Per-Channel Calibration Quality Check

The AIRS L1B product contains a per-scan field named "**CalFlag**". Users should avoid using any channel for any scan in which the "**offset problem**" or "**gain problem**", or "**pop detected**" bits are set (bits 6, 5, and 4 respectively where bit 0 is LSB). Bit 0, "**cold scene noise**", and bit 1, "**telemetry out of limit condition**", indicates conditions that can potentially impact data quality. Users who require pristine data should discard any data in which either of these bits is set.

2.2.2.3 Dynamic Per-Reading Quality Check

Individual channel readings ("**radiances**") must be checked for the fill value of **-9999.0**. A channel reading is set to this value only when no radiance can be calculated; QA fields indicate questionable or suspect (but non-fill) values.

Note that small negative radiances for shortwave channels (2000 to 2700 cm^{-1}) are rare, but valid. These negative radiances values are due to instrument noise, and occur when the scene temperatures drop below 190K, for example, over very high cloud or very cold surface.

2.2.2.4 (Advanced) Dynamic Spectral Frequency

Note that there are two spectral SRF centroids listed in AIRS Level-1B products: **nominal_freq** and **spectral_freq**. Ignore **spectral_freq**. **spectral_freq** is an instantaneous estimate and therefore noisy. It should not be relied upon as QA

indicators. Frequency variations are generally small enough to safely be ignored, but where they are important users should get dynamic frequencies from V6 Level-1C products, which will provide a model of how frequencies are expected to vary with time.

3 Quick Start QA for AMSU-A L1B Data

3.1 Special Note for AMSU Channel 4

AMSU channel 4 worked well initially but then rapidly degraded. Radiances are useful until mid 2007.

3.2 Special Note for AMSU Channel 5

AMSU channel 5 worked well initially but then gradually degraded. Noise level had increased to 0.5 K in January 2010; 1.0 K February 2011; and by February 2012 was 2.0 K and increasing rapidly.

3.3 Special Note for AMSU Channel 7

AMSU channel 7 exhibits abnormal noise levels. Avoid using radiances from this channel unless averaging, smoothing or other noise reduction processing is part of your analysis. Please refer to the AMSU liens list in the Data Disclaimer documentation for details.

V6_Data_Disclaimer.pdf

3.4 Per-Scan Quality Checks

Before using any AMSU-A1 or AMSU-A2 L1B brightness temperature, check the value of the corresponding "**state1**" or "**state2**" to ensure that it is equal to zero.

There is one "**state1**" value for all 30 fields-of-view of a scan, and it is valid for all AMSU-A1 channels (AMSU-A channels 3 through 15).

There is one "**state2**" value for all 30 fields-of-view of a scan, and it is valid for all AMSU-A2 channels (AMSU-A channels 1 and 2).

The "**state1**" and "**state2**" valids and their meaning are:

State Valid	State Value	Meaning
Process	0	normal data
Special	1	instrument in special calibration mode when these data were taken (e.g., staring at nadir)
Erroneous	2	data known bad (e.g., instrument in safe mode)
Missing	3	data are missing

3.5 Per-Channel Quality Checks

Individual channel readings ("**antenna_temp**" or "**brightness_temp**") must be checked for the flag bad value of **–9999.0**. A channel reading is set to this value by the PGE when no actual antenna temperature value can be calculated.

3.6 Advanced Quality Checks

Each scan contains a "**glintlat**" and "**glintlon**" giving the location of the solar glint center at the time in the middle of that scan. Users can use these or the per-field-of-view "**sun_glint_distance**" to check for possibility of solar glint contamination.

Serious glint contamination of AMSU window channels (channels 1,2,3, and 15) is seen when the scene contains substantial water (landFrac < 0.5) and "**sun_glint_distance**" is less than ~50km.

"**qa_receiver_a11**", "**qa_receiver_a12**", "**qa_receiver_a2**", bits 2-6 and "**qa_channel**" bits 0-6 indicate conditions that can potentially, but not usually, impact data quality. Users who require pristine data should discard data when any of these bits are set.

4 Quick Start QA for HSB L1B Data

4.1 Per-Scan Quality Checks

Before using any HSB L1B brightness temperature, check the value of the corresponding "**state**" to ensure that it is equal to zero. There is one "**state**" value for all 90 fields-of-view of a scan, and it is valid for all four implemented channels. The "**state**" valids and their meaning are:

State Valid	State Value	Meaning
Process	0	normal data
Special	1	instrument in special calibration mode when these data were taken (e.g., staring at nadir)
Erroneous	2	data known bad (e.g., instrument in safe mode)
Missing	3	data are missing

4.2 Per-Channel Quality Checks

Individual channel readings (**"antenna_temp"** or "**brightness_temp**") must be checked for the flag bad value of **–9999.0**. A channel reading is set to this value by the PGE when it becomes suspect during processing.

HSB Channel 1 was never implemented, so will always be –9999.0.

HSB data are unavailable after February 5, 2003 due to failure of the scan system of that instrument.

4.3 Advanced Quality Checks

Each scan contains a "**glintlat**" and "**glintlon**" giving the location of the solar glint center at the time in the middle of that scan. Users can use these or the per-field-of-view "**sun_glint_distance**" to check for possibility of solar glint contamination.

Some glint contamination is seen on HSB channel 2 when the scene contains substantial water (landFrac < 0.5) and "**sun_glint_distance**" is less than ~50km.

"**qa_receiver**" bits 2-6 and "**qa_channel**" bits 0-6 indicate conditions that can potentially, but not usually, impact data quality. Users who require pristine data should discard data when any of these bits are set.

Copyright 2017. All rights reserved.